MI-8 Beam Dump

Removal of Long 13 Extraction

Coming Soon – Fall 2005

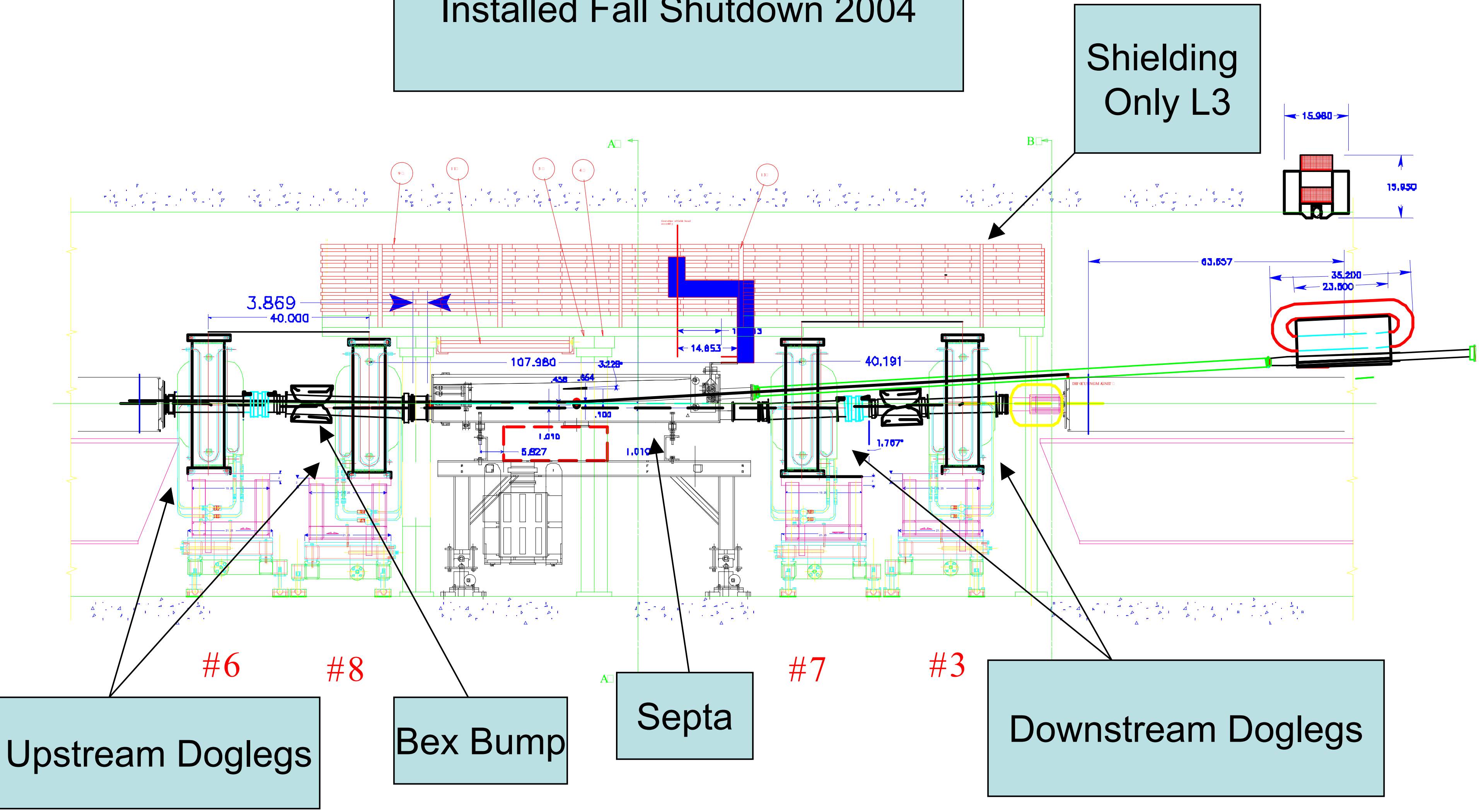
Pro Removal

- Edge Focusing Issue
- Aperture/Alignment Issues
- Tuning Issues
- L3 Extraction Issues
- Real estate
- Activation – component failure

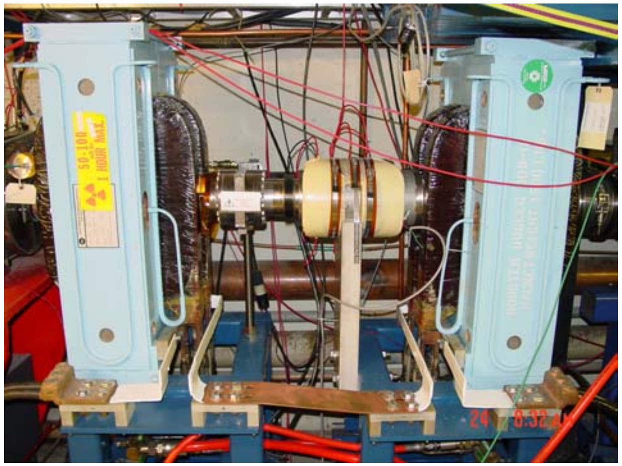
Con Removal

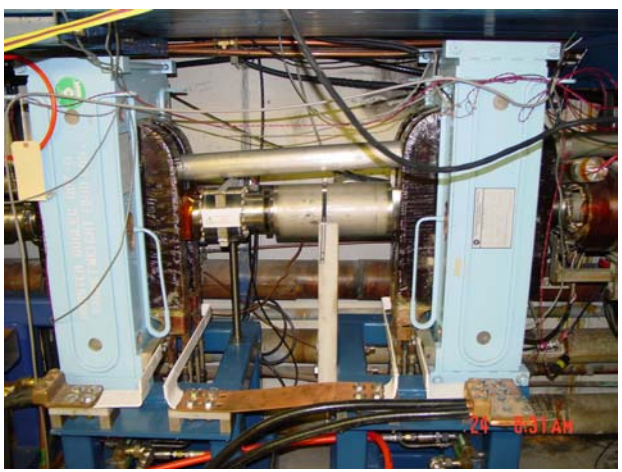
- We Know How It Works
- RDF
- MI-8 Line Beam Loss Issues
- Operating Constraints
- $$
- Utilities – BWG water demand

Present L13 Layout
Installed Fall Shutdown 2004



L13





Edge Focusing

- The linear optics of the Booster is perturbed by the edge focusing of the extraction orbit bumps*.
- Although reduced with new L13 design the effects remain.

* C. Ankenbrandt, W. Chou, A. Drozhdin, J. Lackey, P. Lucas, F. Ostigay, M. Popovic, …. FNAL, Batavia, IL 60510, USA,

"The Edge Focusing Effect of Injection and Extraction Orbit Bumps in the Fermilab Booster"

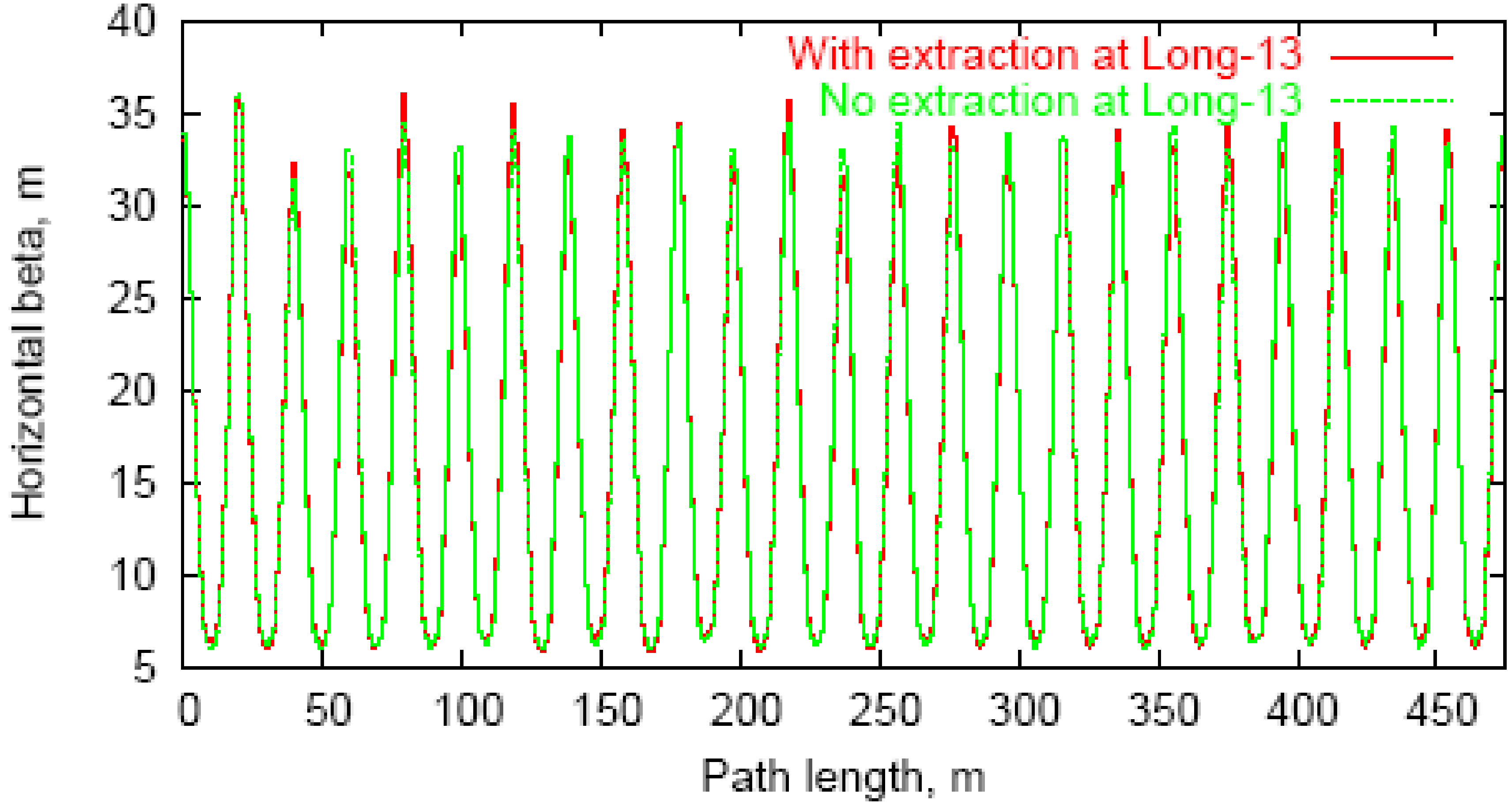
Simulated Lattice Numbers A. Drozhdin

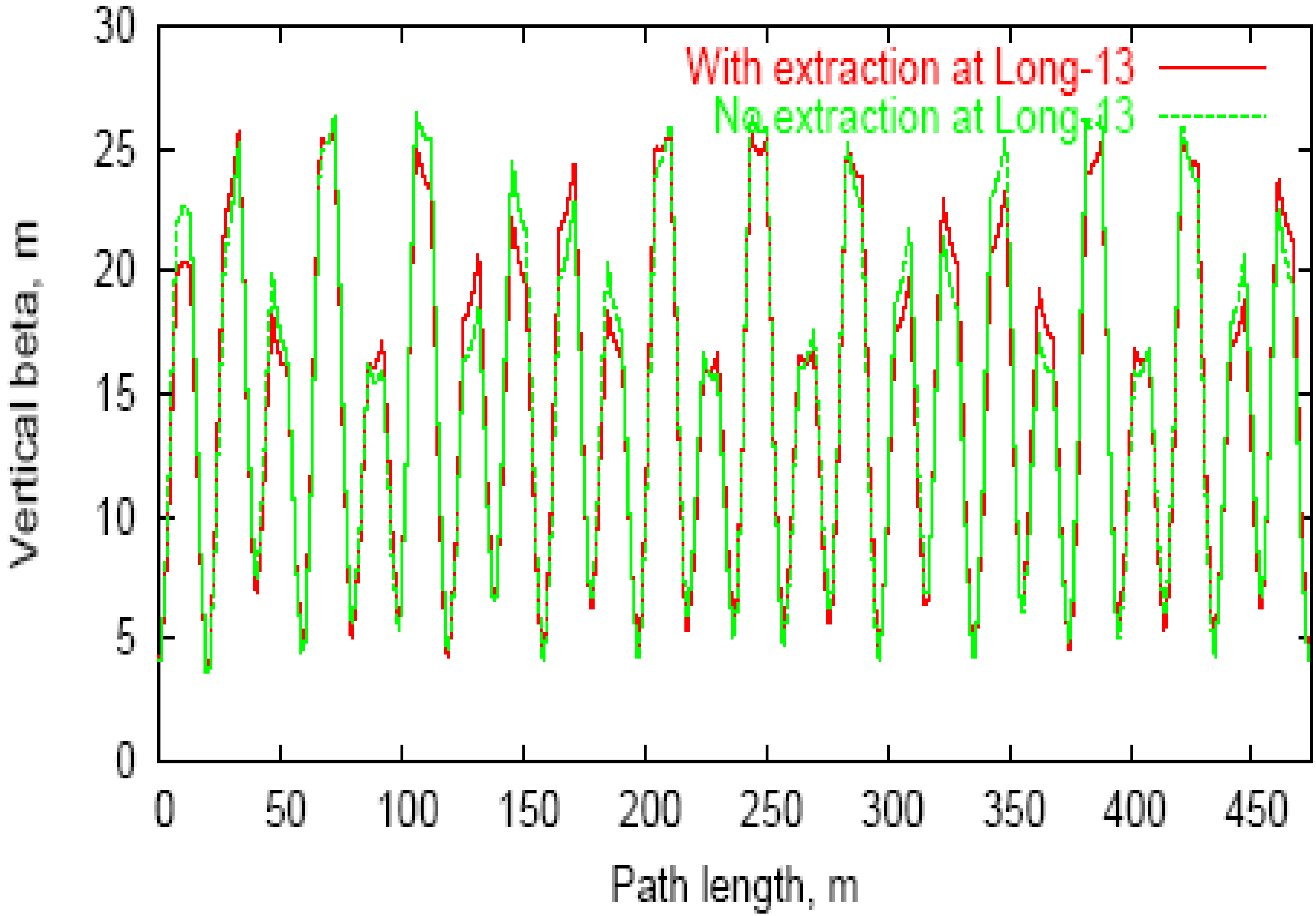
No L-13 extraction

- Total Length = 474.204066 Qx = 6.702875 Qy = 6.833608
- Delta(s) = 0.000000 mm Qx' =-22.029112 Qy' =10.248640
- alfa = 0.336600E-01 betax(max)= 35.940595 betay(max)=26.412676
- gamma(tr) = 5.450585
- Dx(max) = 3.621426 Dy(max) = 0.022589
- Dx(r.m.s.)= 2.484070 Dy(r.m.s.)= 0.002658
- xco(max) = 0.000000 yco(max) = 0.000000
- xco(r.m.s.)= 0.000000 yco(r.m.s.)=0.000000

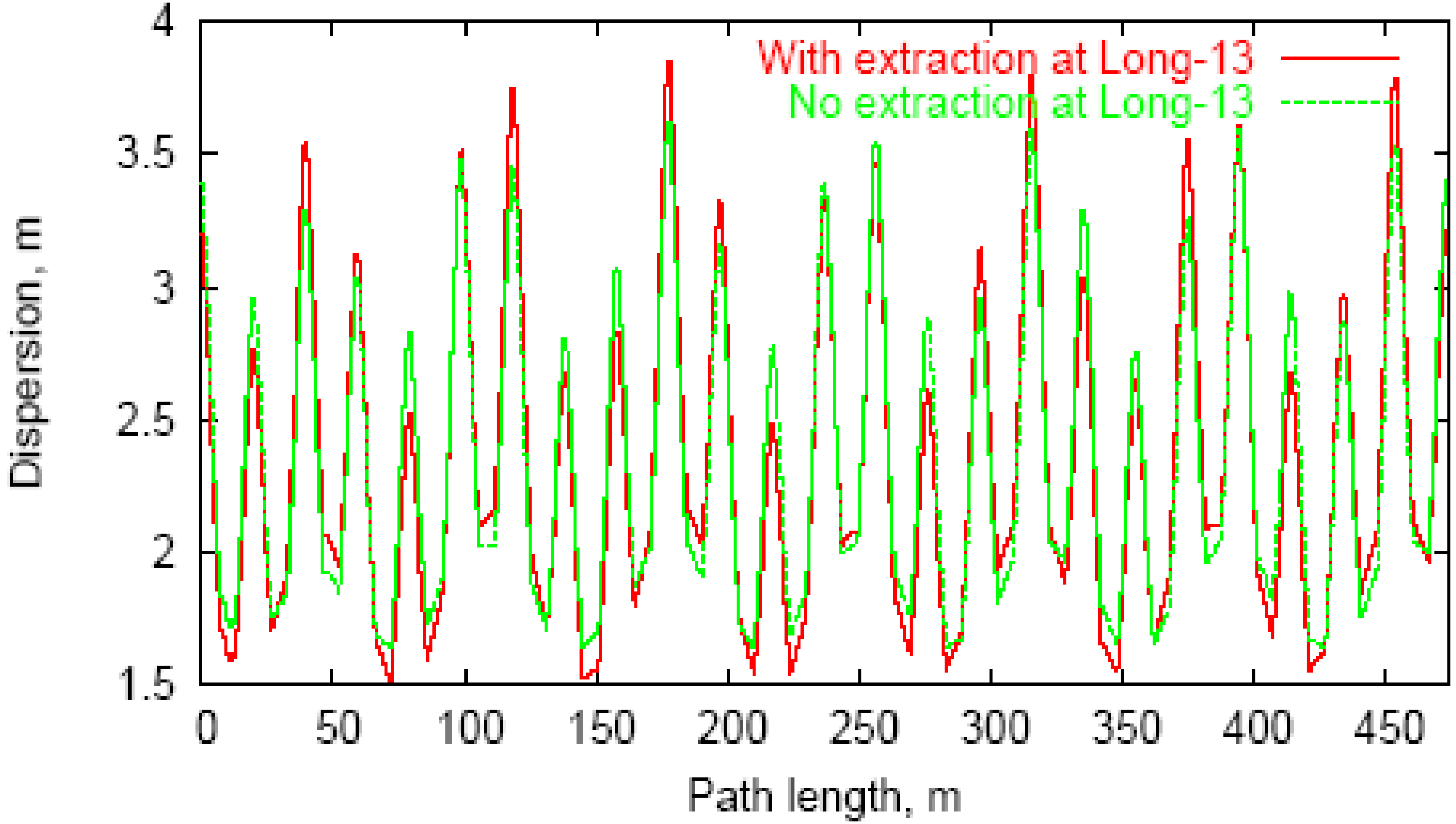
With extraction at Long-13

- Total Length=474.204489 Qx = 6.711246 Qy = 6.818725
- Delta(s) = 0.000000 mm Qx' =-21.962812 Qy' =10.184168
- alfa = 0.335145E-01 betax(max)= 36.048296 betay(max)=25.792870
- gamma(tr) = 5.462400
- Dx(max) = 3.847574 Dy(max) = 0.021389
- Dx(r.m.s.)= 2.480990 Dy(r.m.s.)= 0.003719
- xco(max) = 0.000000 yco(max) = 0.000000
- xco(r.m.s.)= 0.000000 yco(r.m.s.)=0.000000


With extraction at Long-13
No extraction at Long-13
Horizontal beta, m
Path length, m
40
35
30
25
20
15
10
5
0
50
100
150
200
250
300
350
400
450



With extraction at Long-13
No extraction at Long-13
Vertical beta, m
Path length, m
0
5
10
15
20
25
30
0
50
100
150
200
250
300
350
400
450



With extraction at Long-13
No extraction at Long-13
Dispersion, m
Path length, m
4
3.5
3
2.5
2
1.5
0
50
100
150
200
250
300
350
400
450

Aperture/Alignment Issues

- The calculated aperture is approximately 80mm(H) by 60mm(V). Large enough to accept 20 pi beam. The actual aperture as measured by scans is 44mm H by 20mm V.

1. There is some error in the scan data do to scraping outside the area of measurement.
2. Alignment error may explain part of the discrepancy.
3. The local beta bumps may result in an increased vertical beam size.

Tuning Issues

- The region is not as shielded as the L3 extraction region.
  - BLM limits are set lower than L3
  - Efficiencies above 87% still require collimating to reduce losses to acceptable limits
- The tuning at L13 is critical for L3 extraction (ring wide beam loss issues)
  - L13 bex bump, septa and dogleg tuning
  - Vertical tune
  - Extraction Kickers at L2 for use at L3 is limited

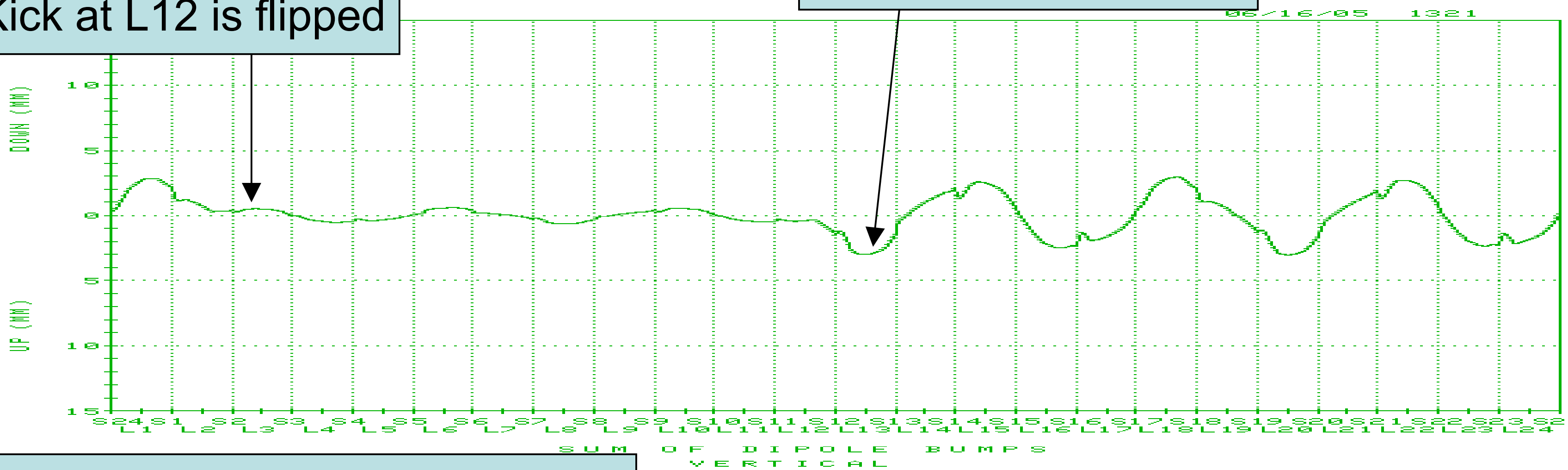
MI-8 Dump Operation

- Total Beam expected is ~ 1E19 p/yr
- L13 dump integrated protons ~2.9E18 p/yr
- MI-8 design goal is 1E20p/yr
- Two operational modes
  - Short Batching to MI
    - Protons for colliding mode – Beam cycle $15
    - Protons for fixed target mode – Beam cycle $13
  - Booster Study Cycles – Beam cycle $17
    - MI secured – V803B is on
    - MI Rad permit down – V803B is off, Beam stop closed

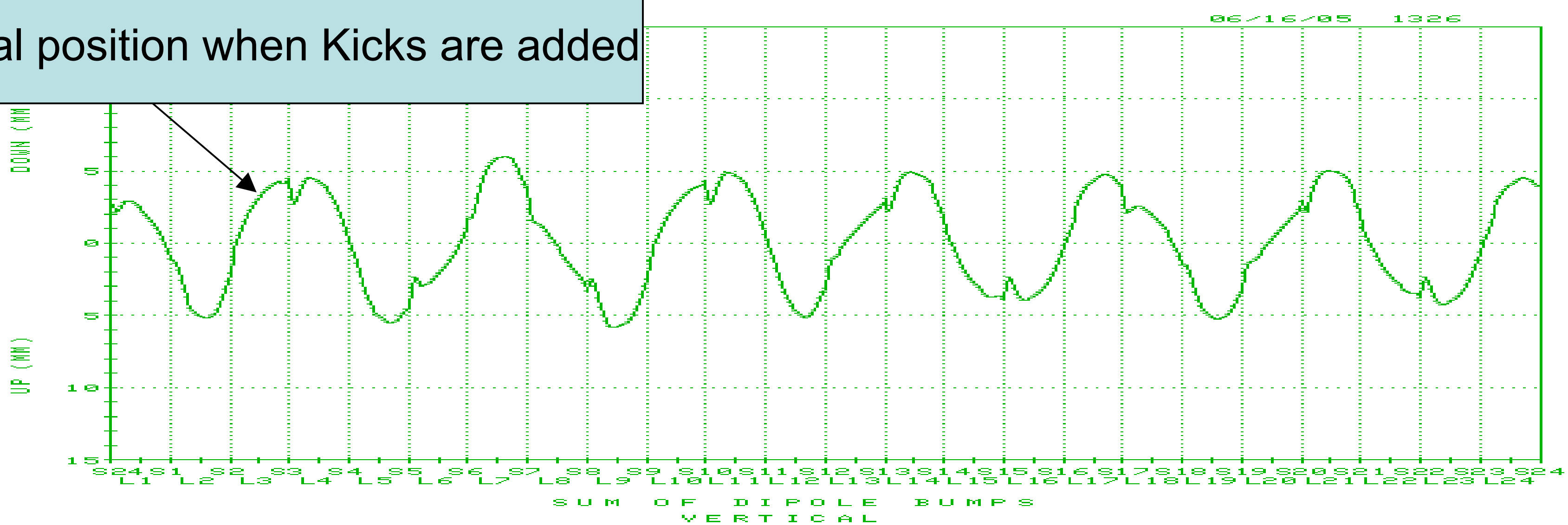
Kicker(s) at L12 can be used to extract beam at L3. This will allow L3 extraction kickers (MKS05,06,07,08) to be turned down. Higher kicker lifetime and operational spare.

Kickers at L2 and L12
When Kick at L12 is flipped

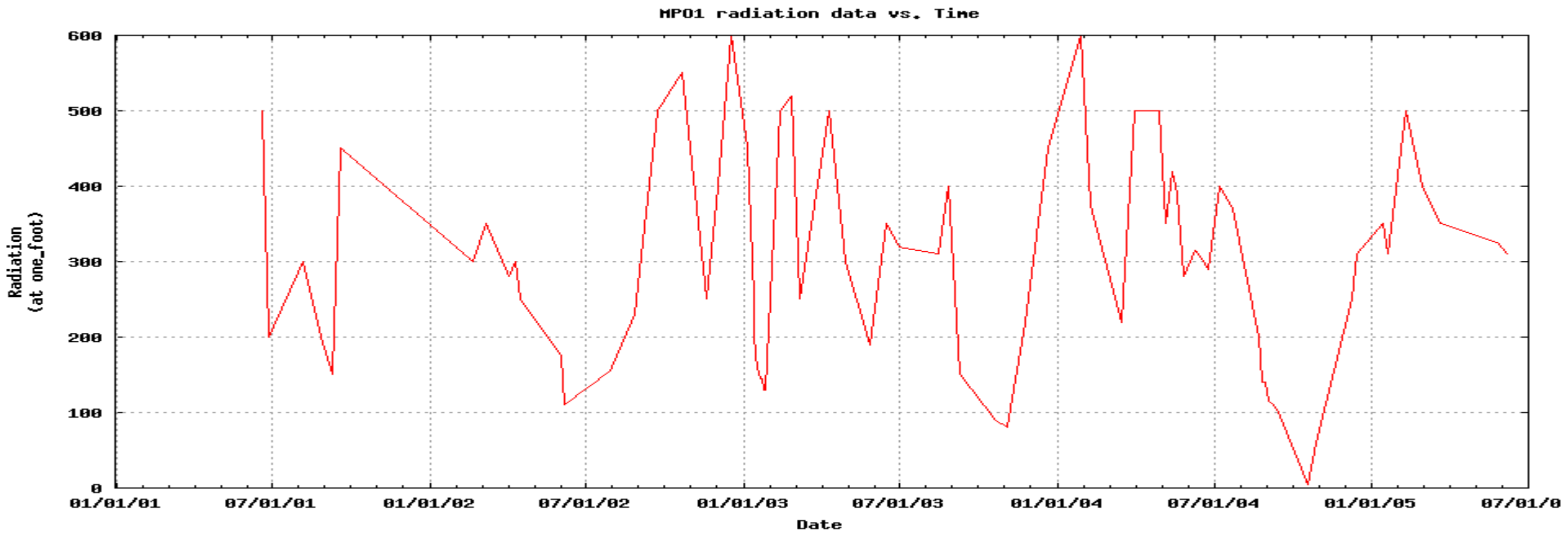
MP01 aperture issues



L3 Vertical position when Kicks are added



Activation - Septa



- Component failure in this region has been high. We have made improvements (peek water tubing) but other systems are still vulnerable.
- Caps, Correctors, Cables, Ion Pump….etc

New Home Booster Beam Dump
MI-8 Line

MKS01

MKS02

MKS03

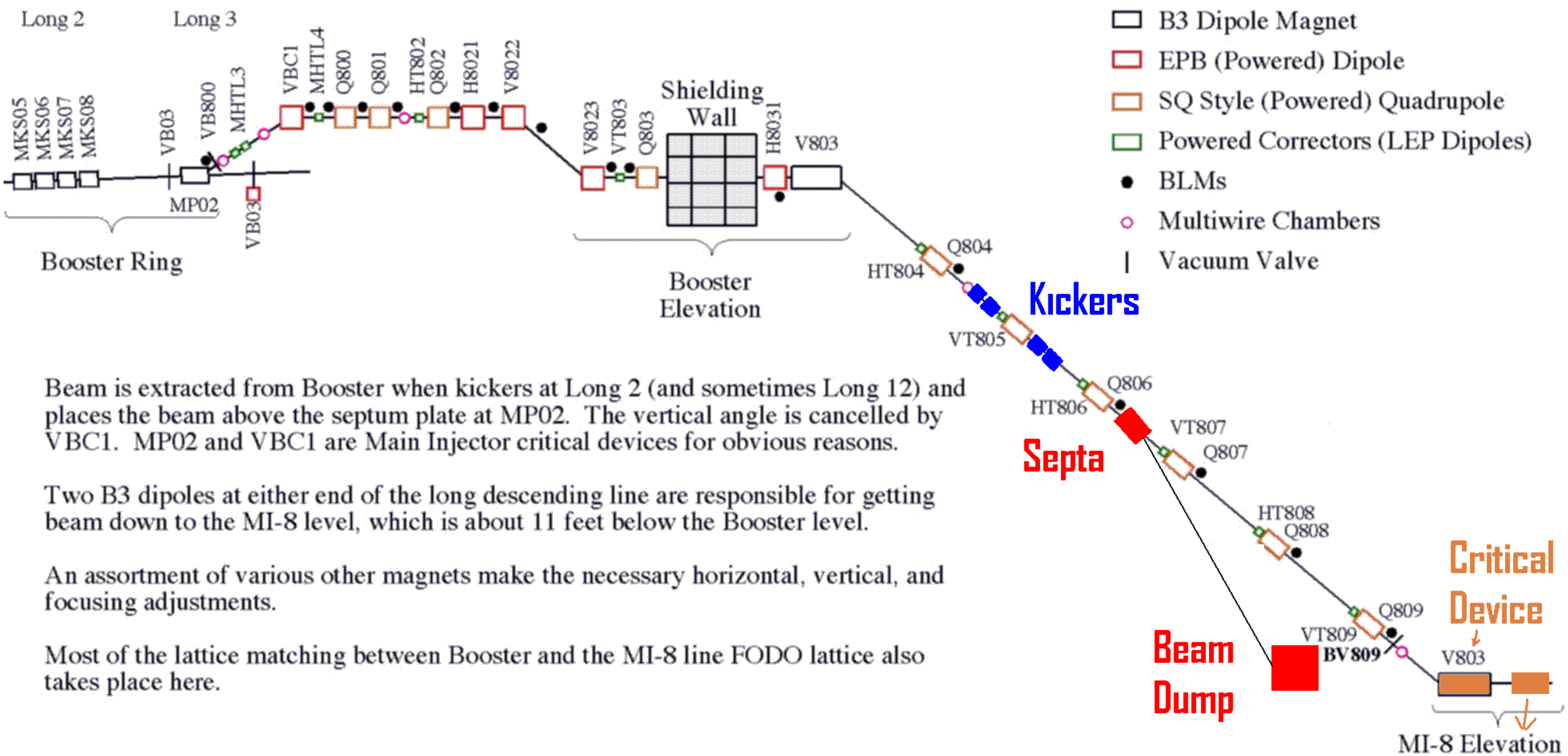
MKS04

Mi-8 (Q807)

Septa

Dump

New MI-8 Layout ‘A’



Vertical Profile of Upstream of MI-8 Line 'A'

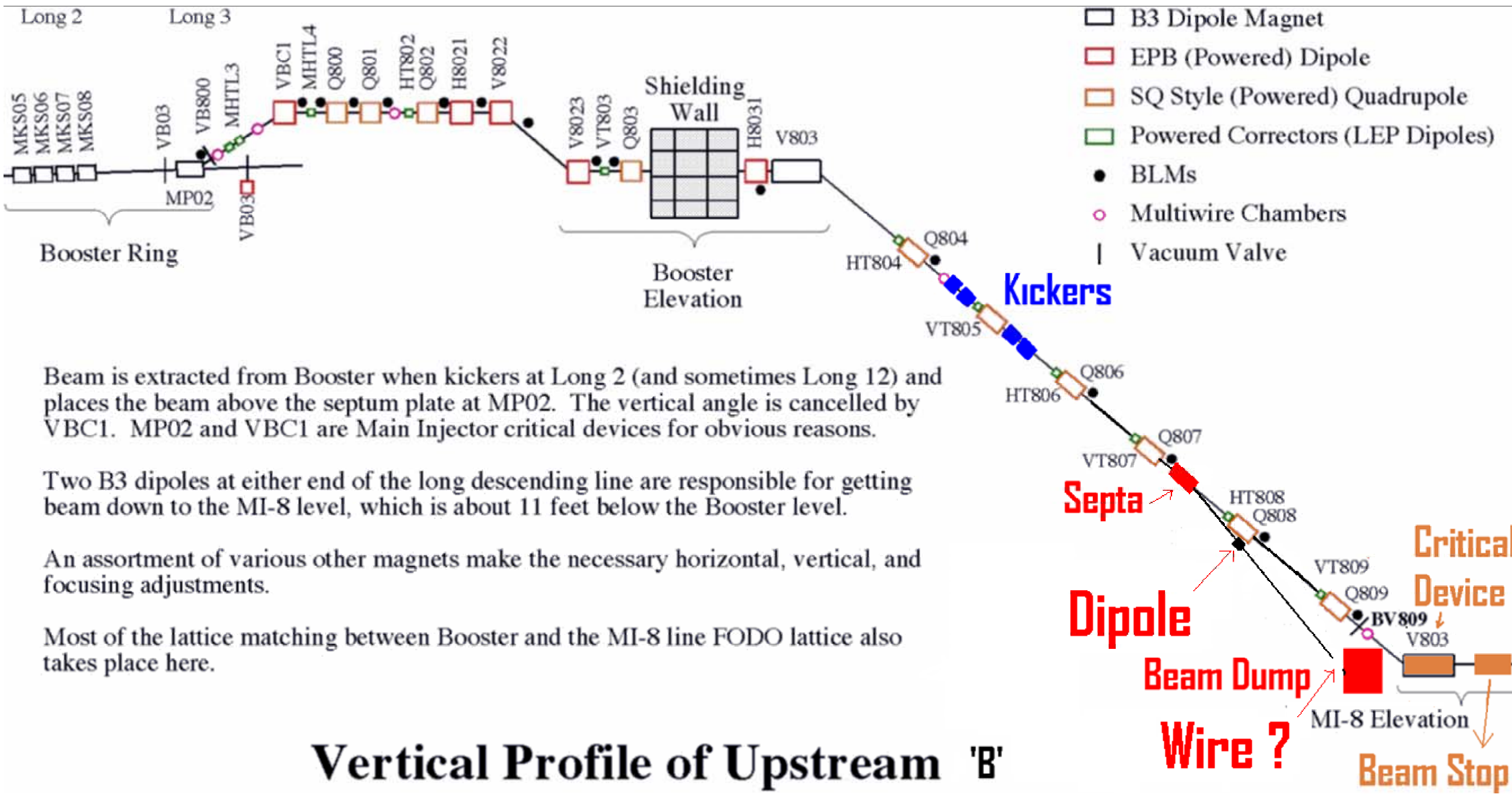
Beam is extracted from Booster when kickers at Long 2 (and sometimes Long 12) and places the beam above the septum plate at MP02. The vertical angle is cancelled by VBC1. MP02 and VBC1 are Main Injector critical devices for obvious reasons.

Two B3 dipoles at either end of the long descending line are responsible for getting beam down to the MI-8 level, which is about 11 feet below the Booster level.

An assortment of various other magnets make the necessary horizontal, vertical, and focusing adjustments.

Most of the lattice matching between Booster and the MI-8 line FODO lattice also takes place here.

New MI-8 Layout ‘B’



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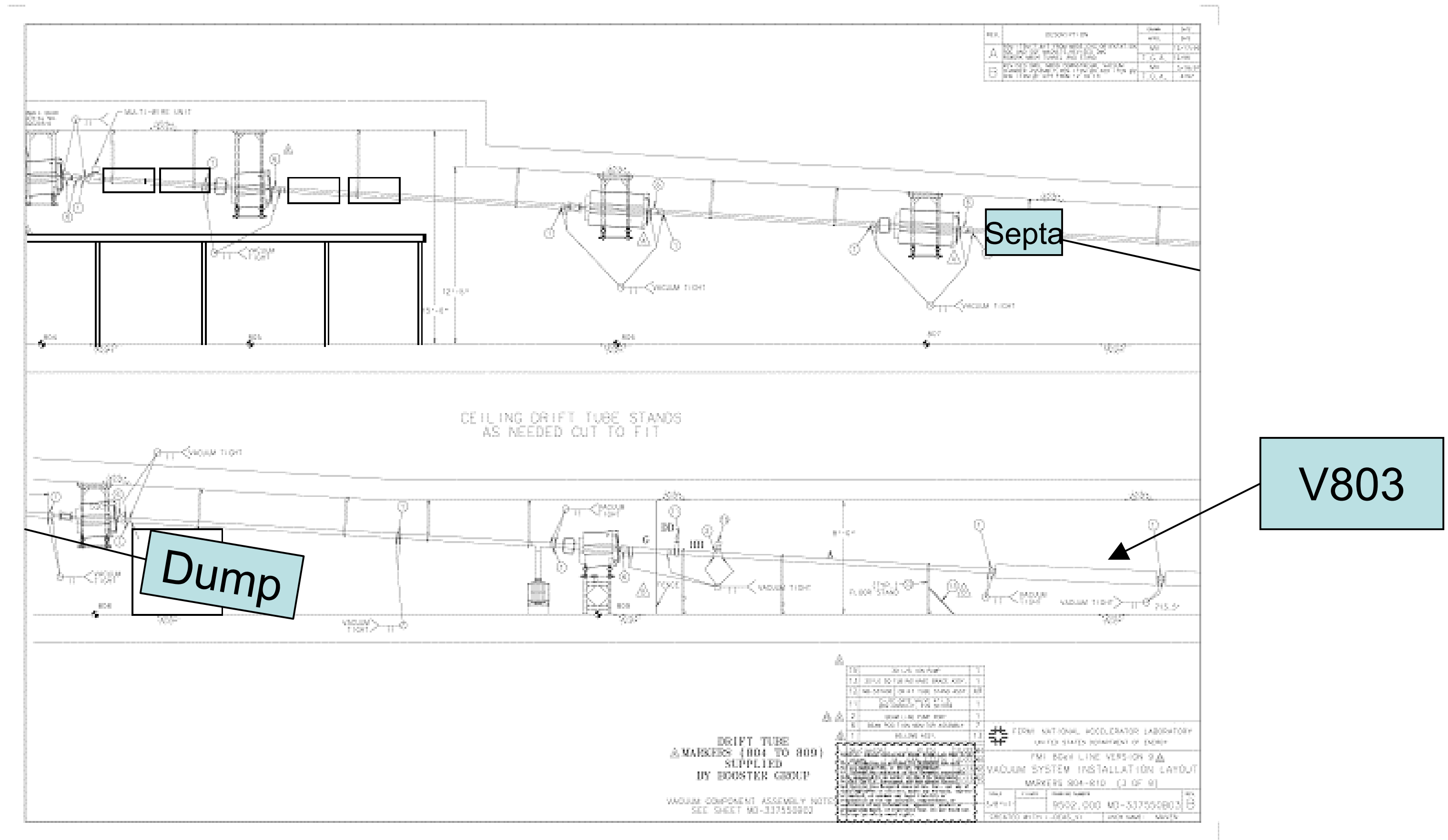
Vertical Profile of Upstream 'B'

MI-8 Drawing Downstream Septa



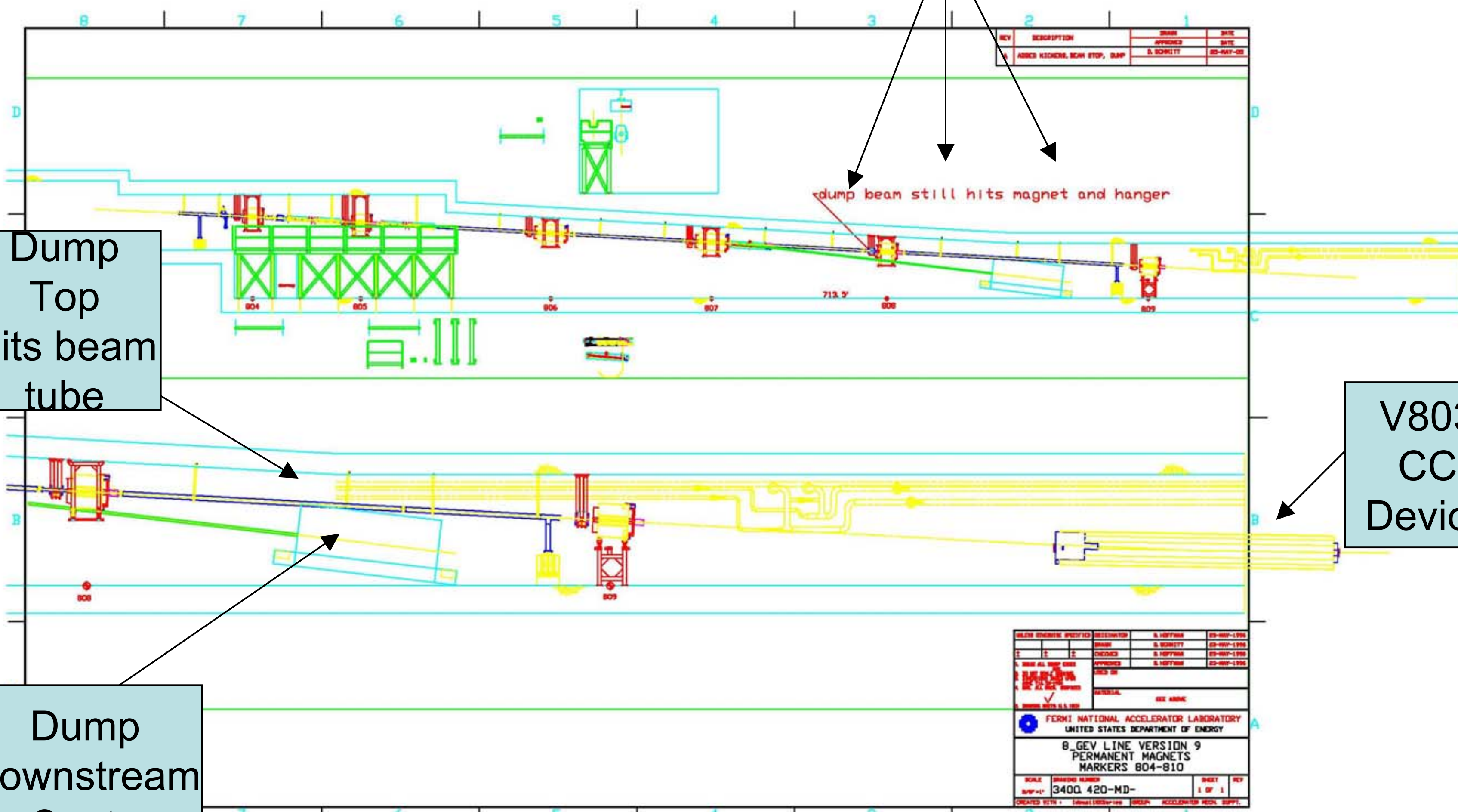
View #2
Rob Reilly

Upstream Septa

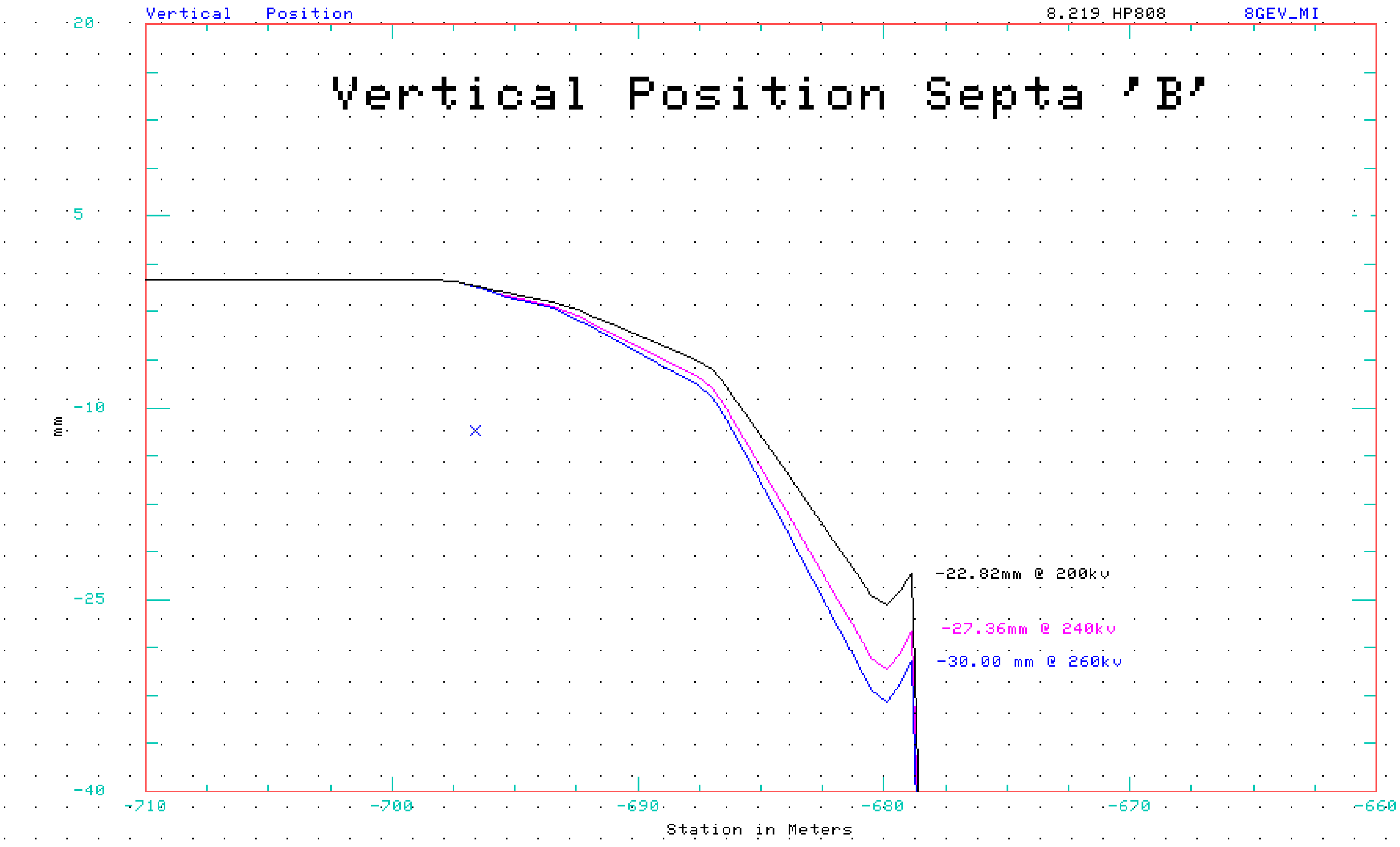
Dump Top Hits beam tube

V803 CC Device

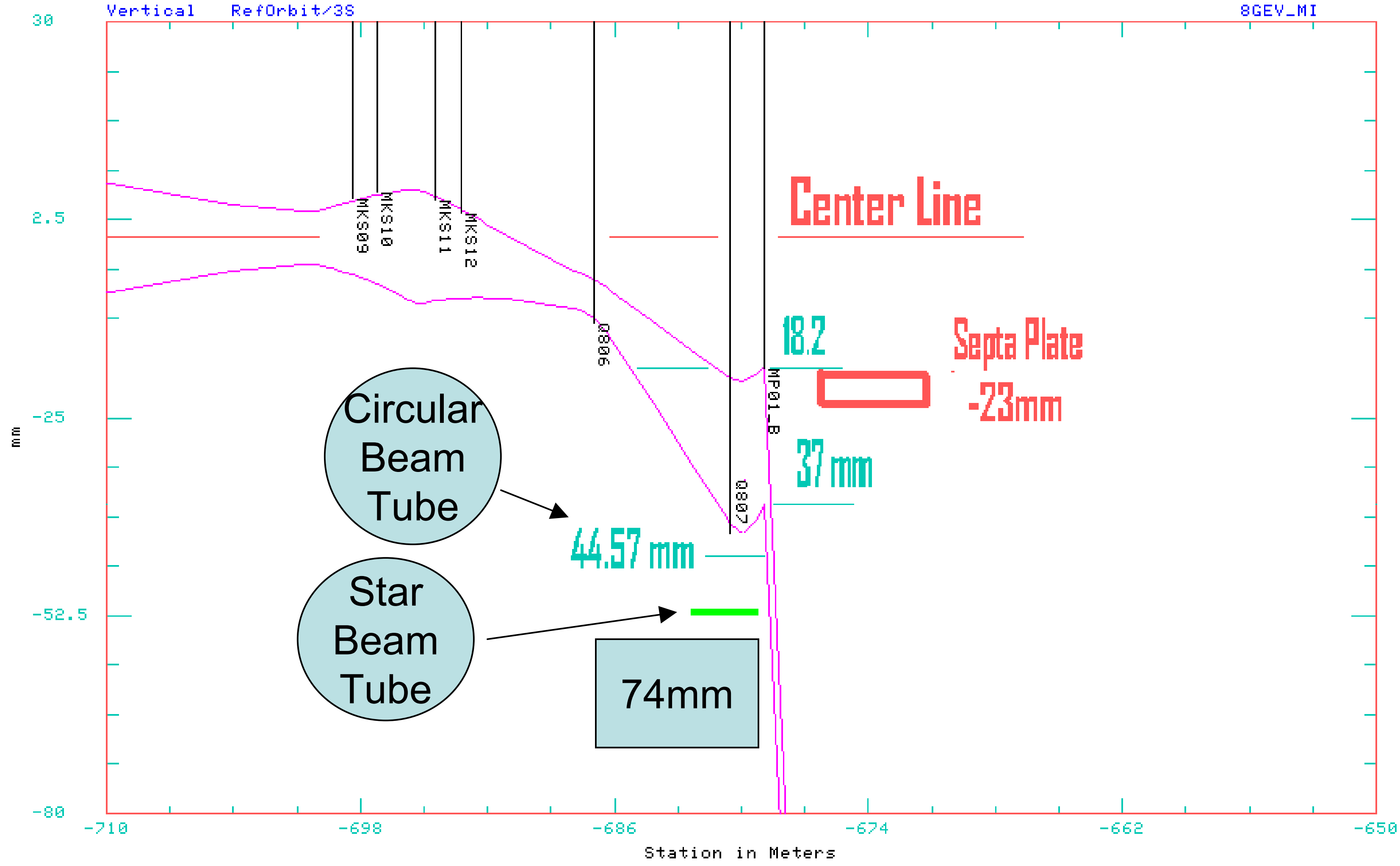
Dump Downstream Septa



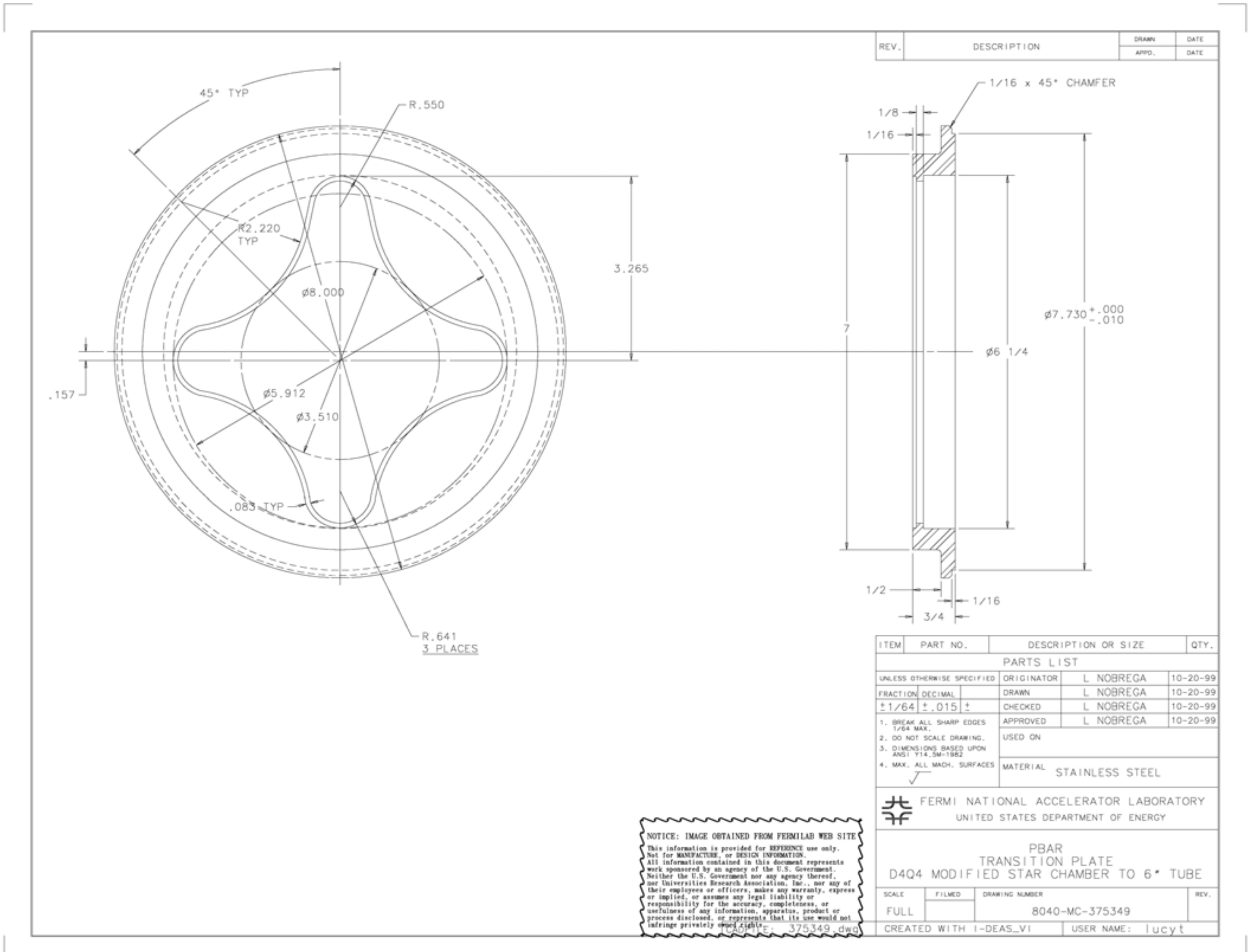
Vertical Position at Septa



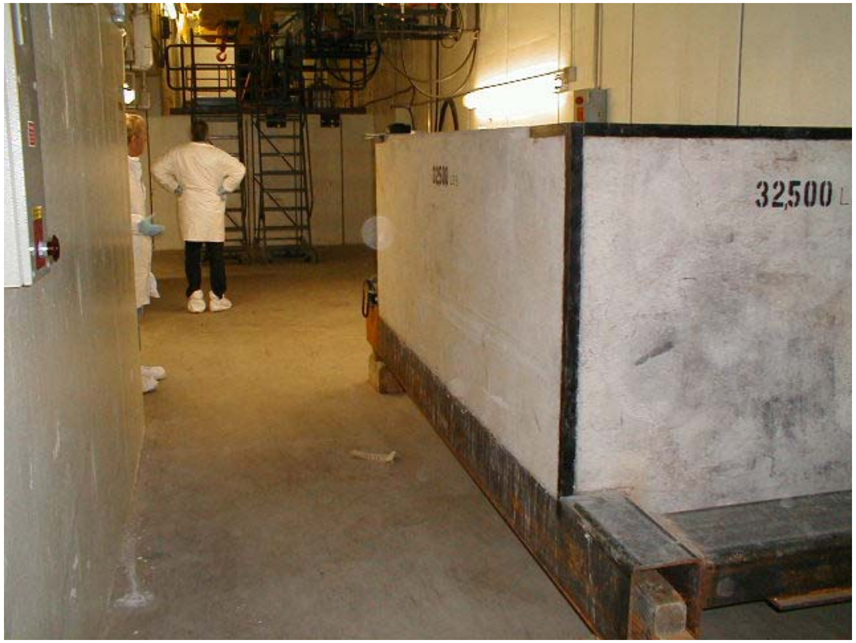
Beam size at Septa (240KV)



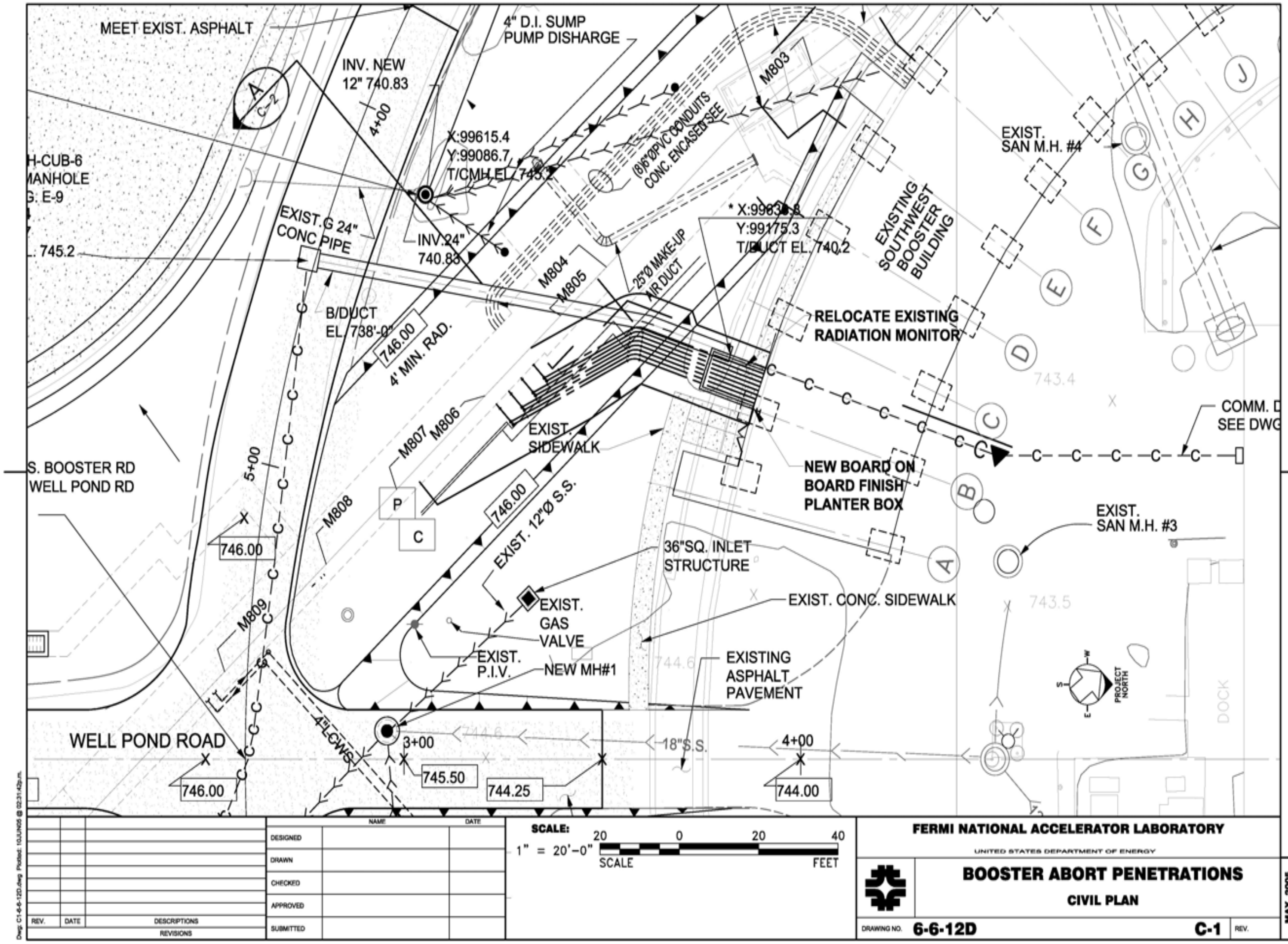
Star Beam Tube for Q808



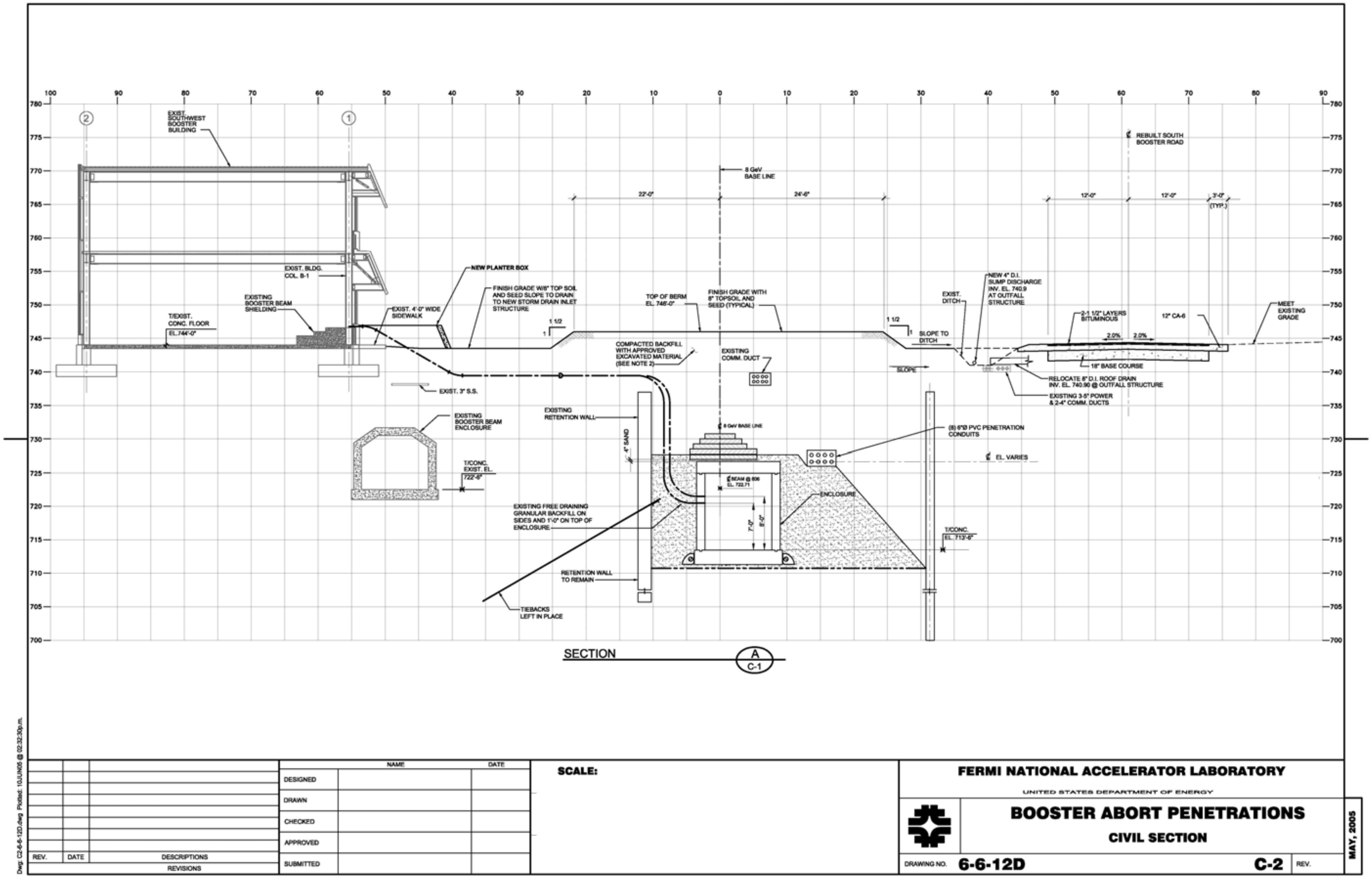
Dump – MI-8 commissioning Dump



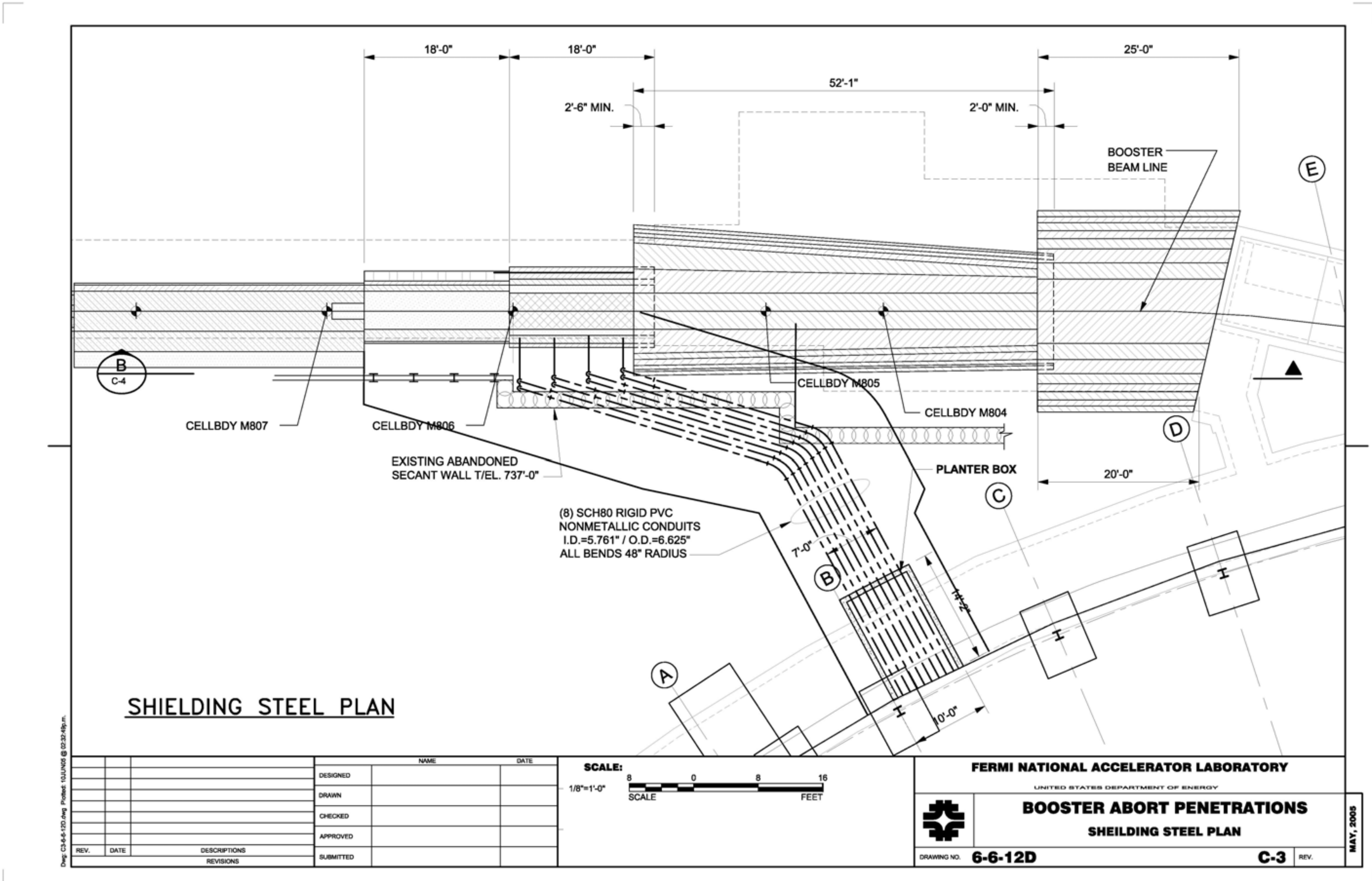
Booster Abort Penetrations Tom Lackowski



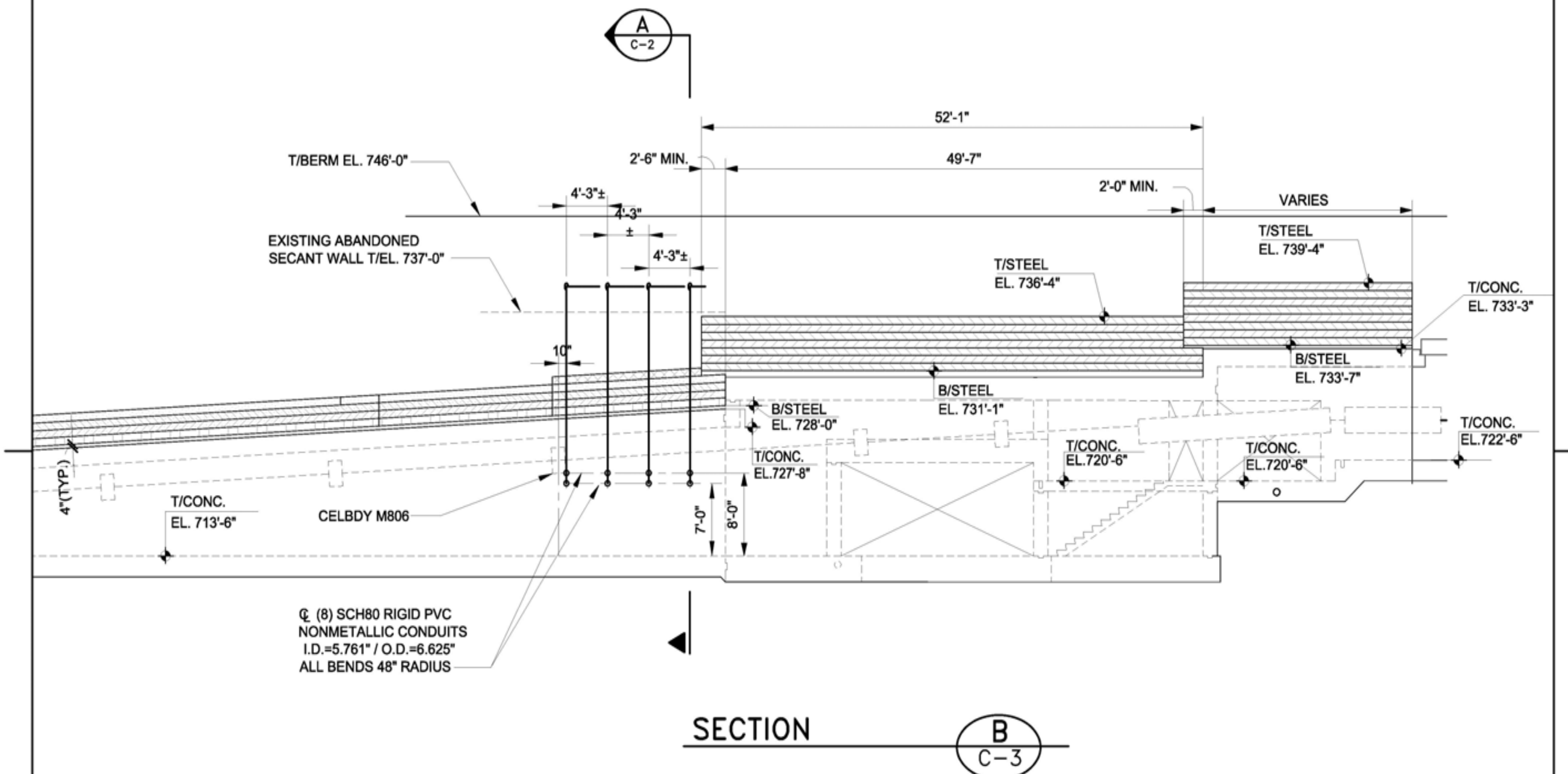
Tunnel View - Penetrations



Overhead View



Side View



REV.	DATE	DESCRIPTIONS		NAME	DATE
			DESIGNED		
			DRAWN		
			CHECKED		
			APPROVED		
		REVISIONS	SUBMITTED		

SCALE:
1/8"=1'-0" 8 0 8 16 SCALE FEET

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

BOOSTER ABORT PENETRATIONS
SHEILDING STEEL SECTION

DRAWING NO. **6-6-12D** **C-4** REV.

MAY, 2005

Dwg: C4-6-6-12D.dwg Plotted: 10JUN05 @ 02:33:06p.m.

Cost ?

150,000
to
170,000

Uniq	WBS	Name	Start	Finish	Res	Hours	Labor $$	M&S	Comments
284	**1.2.11**	**Booster Dump Relocation**	**5/2/05**	**12/1/05**		**1,692 h**	**$47,545**	**$105,000**	
286	1.2.11.1	Booster Dump Relocation Design	5/2/05	6/29/05	AD Mechanical Engineer[25%],AD Engineer[25%]	168 h	$7,543	$5,000	
427	1.2.11.2	Review Booster Dump Relocation Design	7/5/05	7/5/05		0 h	$0	$0	
416	1.2.11.3	Design Kicker Support Platform	5/16/05	6/30/05	AD Mechanical Engineer[12%]	32 h	$1,437	$0	
288	1.2.11.4	Misc Fabrication	7/6/05	8/3/05		0 h	$0	$28,000	Revised M&S
417	1.2.11.5	Build Kicker Support Platform	10/31/05	11/11/05	AD Mechanical Technician	80 h	$1,722	$10,000	
287	**1.2.11.6**	**Booster Dump Relocation Install**	**5/2/05**	**12/1/05**		**1,412 h**	**$36,843**	**$75,000**	
289	1.2.11.3.1	Remove Existing MP01 Septum	11/30/05	12/1/05	AD Mechanical Technician[300%]	48 h	$1,033	$0	
290	1.2.11.6.2	Install Replacement MP01 (Old MI-8) Septum	10/31/05	11/4/05	AD Mechanical Technician[300%]	120 h	$2,582	$0	
383	1.2.11.6.3	Run Power to MP01 Septum	5/2/05	6/30/05		0 h	$0	$4,000	
384	1.2.11.6.4	Run Cooling Water to MP01	6/1/05	6/14/05		0 h	$0	$4,000	
291	1.2.11.6.5	Remove Booster Kickers	11/7/05	11/7/05	AD Mechanical Technician[300%]	24 h	$516	$0	
292	1.2.11.6.6	Install Booster Kickers	11/8/05	11/14/05	AD Mechanical Technician[300%]	120 h	$2,582	$0	
293	1.2.11.6.7	Relocate Power Supplies	10/31/05	11/11/05	AD Electrical Technician[200%],AD Mechanical Technician[200%]	320 h	$6,886	$0	
369	1.2.11.6.8	Remove Beam Pipe @Conduit Core Location	10/31/05	10/31/05	AD Mechanical Technician[200%]	16 h	$344	$0	
294	1.2.11.6.9	Install Conduit/Cable Pulls	11/1/05	11/21/05	FESS	60 h	$2,694	$60,000	
368	1.2.11.6.10	Terminate/Splice Cables/Controls	11/22/05	11/28/05	AD Electrical Technician[300%]	72 h	$1,549	$0	
295	1.2.11.6.11	Install Dump	10/31/05	11/1/05	AD Mechanical Technician[400%]	64 h	$1,377	$7,000	
296	**1.2.11.6.12**	**Radiation Safety Modifications**	**5/16/05**	**11/11/05**		**328 h**	**$10,799**	**$30,000**	
418	1.2.11.5.12.1	New PS for V803B	6/1/05	6/30/05	AD Mechanical Technician[14%]	24 h	$516	$14,000	
419	1.2.11.6.12.2	Pull Cables for V803	10/31/05	11/11/05	AD Electrical Engineer[200%]	160 h	$7,184	$4,000	
420	1.2.11.6.12.3	Beam Stop Fabrication	5/16/05	7/29/05		0 h	$0	$8,000	
421	1.2.11.6.12.4	Install Beam Stop	10/31/05	11/11/05	AD Mechanical Technician[30%]	24 h	$516	$2,000	
422	1.2.11.6.12.5	Recable Interlock Chassis & Test	10/31/05	11/11/05	AD Electrical Technician[150%]	120 h	$2,582	$2,000	
297	1.2.11.6.13	Alignment	11/11/05	11/14/05	PPD Survey Engineer[500%],PPD Survey Technician[1,000%]	240 h	$6,478	$0	
322	1.2.11.6.14	Booster Dump Relocation Installation Complete	11/14/05	11/14/05		0 h	$0	$0	

Booster Abort Relocation

Conduit Routing

May 23. 2005

Conclusion

- Removal of L13 extraction will be a noticeable improvement to Booster operations.
- Cost of relocation is small.
- Risk of relocation is small.
- Reduction in Booster activation levels

Thanks to AD mechanical, FESS, AD Safety